MISCELLANEOUS FIELD STUDIES

GLACIOALLUVIAL DEPOSITS

which lie within the boundaries of moraines and are of

limited extent, and (3) the series of outwash apron and

Kame and esker deposits were laid down by streams

flowing within, on, or around the glacier, probably after it

had become stagnant, in tunnels or channels bounded by ice

valley-train deposits that extend outward from moraines.

so that when the ice melted, mounds of the accumulated

stream deposits remained lying in thicker piles than the

were laid down within or just outside the bounds of the

Outwash-train deposits were laid down by meltwater streams

that extended beyond the margins of the glacier either in

moraines of previous, more extensive glaciers. In general,

the older outwash-train deposits date from the time that the

ice had reached its maximum extent; kame and esker deposits

date from the time when the ice subsequently became stagnant

and may correlate with some of the intermediate-age outwash-

train deposits; outwash-channel deposits and the younger

outwash-train deposits date from latter stages of ice

stagnation, perhaps when the active glacier front had

Of these three deposit types, the outwash-train

the moraines. With respect to the oldest moraines, the

outwash deposits are mainly scattered remnants of formerly

more continuous systems now quite limited in areal extent.

The Seven-thirty lake outwash forms a highly dissected but

reasonably continuous system that drains southward in the

central part. We have divided these deposits into higher

The Denslow Lake valley trains constitute the most

a complex of levels that dominates the eastern part of the

map area. We have divided these valley trains into seven

units, as summarized in figure 6. The highest and oldest

unit (do) drains southward at the west side of the complex.

the east, and the lowest and youngest unit (du) drains

basis of photogrammetrically determined elevations of

plotted along reasonable gradients were grouped into a

single terrace unit. There is some uncertainty in the

units are only remnants not directly traceable to the

grouping of the terrace remnants into the resulting seven

units, and along the length of any one unit there may be

mismatches by one or two units. Some of the intermediate

moraine. It is also possible that what we have identified

as the younger of the Seven-thirty outwash trains instead

preservation from those related to other moraines that the

separate glacial events. We think, however, that the amount

likely on the order of thousands or even tens of thousands

of years rather than hundreds of thousands, and thus that

significant ice retreat and readvance. On the other hand,

the age difference between the units related to any one

moraine may instead be on the order of several hundred to a

OTHER SURFICIAL DEPOSITS

Post-glacial alluvium, colluvium (including landslide

occurs in the valley bottoms of the principal streams and in

Four faults are shown trending northeasterly across the

faults are based and on the degree of confidence that can be

placed on their authenticity. Only the Lone Ridge fault, in

others (1963) and of Hackett (1977), whose model includes it

within a complex of reverse faults. On other maps, however,

smaller scale compilations show a fault at this location as

indicate or imply that the Lone Ridge fault is a direct link

a strike-slip fault (King, 1969) or do not give a sense of

relative movement (Beikman, 1980). Most previous maps

inferred normal fault (Barnes, 1966), is shown here, whereas

a concealed thrust fault (Magoon and others, 1976) or an

map area, based mainly on the work of others. There is

variation in the nature of the evidence on which these

expression and thus is located with confidence. On the

and by us, we concur with the portrayals of Grantz and

basis of field examination by Detterman and others (1976)

the northwestern part of the map area, has surface

of time between each such event in an absolute sense is more

the several younger moraines, at least, may all be part of a

most cases sufficiently distinct in level and degree of

moraines themselves probably resulted from distinctly

single major glaciation, although perhaps representing

deposits), and bog and pond deposits are the principal

remaining deposits types mapped at the surface. Alluvium

few thousand years.

could be the oldest one related to the Denslow Lake moraine.

The outwash units assignable to each moraine are in

valley trains, some partly contemporaneous with some of

The terraced outwash units were established on the

terrace remnants. Those remnants whose elevations could be

several intermediate units lie in an irregular succession to

southeastward in the valley of Lone Creek. Still other such

extensively developed system of terraced outwash deposits in

level (older) and lower level (younger) units.

those mapped here, are east of the map area.

central part of the map area and southeastward in the east-

deposits are the most revealing of age relationships among

retreated considerably upvalley.

existing valleys or in channels newly eroded through the

glacier, during and after the waning stages of ice

stagnation. Deposition occurred in channels that were

eroded into areas of moraine and ice-contact deposits.

LOCATION OF MAP AREA INTRODUCTION and others, 1972). The Denslow Lake moraine thus is clearly late Pleistocene in age, and it may well be that all of the moraines in the map area, except perhaps for the Upper All of the northwestern quarter of the Tyonek A-4 Chuitna ground moraine and the erratics on Lone Ridge, are quadrangle is within the Beluga plateau (Schmoll and others, part of a single glaciation of this age. Other evidence 1984), which has been the subject of increasingly intensipresented in the discussion of the Lone Ridge fault, fied coal exploration (Patsch, 1975; Ramsey, 1981), and however, suggests that a longer period of time may be open-pit coal mining has been proposed at various sites in represented by these moraines, and thus possibly more than this part of the quadrangle. Consequently, we studied the area in order to gather and compile geologic data relevant In our regional synthesis (Schmoll and Yehle, 1986) we to such potential development (Schmoll and others, 1981). have grouped moraines and related stratigraphic units into and this map is part of that effort. Other maps of potenfive "glacioestuarine associations." Each of these bodies tial coal mining areas near Capps Glacier, to the northwest, of deposits is associated with a distinctly different have been released previously (Yehle, Schmoll, and inferred terminal position of a glacier. Most such Chleborad, 1983a, 1983b; Yehle, Schmoll, and Gardner, 1983) positions are not represented by moraines, probably because The Beluga plateau is one of the higher lying physiothe front of the ice was in water of the contemporaneous graphic subdivisions of the Cook Inlet-Susitna lowland (fig. Cook Inlet. According to this interpretation (fig. 4), the Elevations range from highs of more than 550 m on Lone glacier that produced the Blueberry hill moraine, coalescent Ridge, in the northwestern part of the map area, to a low of with glaciers from several sources around the basin, may about 100 m along the Chuitna River, at the south edge. An have extended south to about East Foreland. The Threemile approximate median elevation of 230 m is defined by the 750-Creek and perhaps Fourteen-oh-five lakes glaciers, also ft contour that extends northeasterly across the map from coalescent, extended to about Point Possession. The front near the lower left corner to near the upper right corner, of the Nikolai glacier may have been in Cook Inlet water as reflecting the general regional slope to the southeast of well, about 25 km southeast of the map area, at the same the moderately rolling to hummocky terrain. time that Susitna-Yentna ice terminated near Fire Island and The map area is drained into Cook Inlet almost Beluga ice formed the Eight-ten lake and the somewhat later entirely by the Chuitna River and its tributaries (fig. 2) Seven-thirty lake moraines on the Beluga plateau, above the which have incised narrow valleys about 50-100 m deep. T level of inlet waters. The still-later Denslow Lake glacier principal tributaries of the Chuitna River are (1) Lone terminated on the plateau perhaps when the Matanuska and Creek, which drains southeastward in the northeastern part Knik glaciers terminated in the vicinity of Anchorage, south of the map area, joining the Chuitna River farther east; (2) of the Elmendorf Moraine, and Susitna-Yentna glaciers did a south-flowing unnamed creek that dominates the eastnot reach nearly that far south. The evidence from this map central part of the map area and that is informally referred area, combined with data from Anchorage, seems to support the contention embodied in our regional synthesis that with major western tributaries that dominates the westmoraines of similar morphology, such as the Nikolai, Denslow central part of the map area and that is informally referred Lake, and Elmendorf, are not necessarily of exactly the same to here as "Lone Ridge creek" because of its origins in age; morphological development of moraines may be related springs on Lone Ridge in the northwest corner of the map more to environment of deposition, for example, the presence area; and (4) a generally east-flowing unnamed creek that or absence of inlet water at the ice front, than to age. joins the Chuitna River in the southwest corner of the map area, identified on figure 2 as "South fork." Small parts of the map area drain northward to the Beluga River, mainly by way of Scarp Creek, and southward directly to Cook Inlet by way of Tyonek Creek and Old Tyonek Creek. area are the deposits of streams associated with glaciers Bedrock in most of the map area consists of continenfrom which they were derived. These include (1) kame and esker deposits and (2) outwash-channel deposits, both of

DEPARTMENT OF THE INTERIOR

tal, coal-bearing sedimentary rocks of the Tyonek Formation, a unit of the Kenai Group; it is early Oligocene through middle Miocene in age (Wolfe and Tanai, 1980). Similar rocks of the next voungest formation of the Kenai Group, the Beluga Formation of middle and late Miocene age (Wolfe and Tanai, 1980), are thought to be present in the southeastern part of the map area, mainly southeast of what we here term the "Moquawkie fault zone." A body of plutonic rock of Late Cretaceous and(or) early Tertiary age occupies the northwest corner of the map area and is separated from the Tyonek Formation by a fault that we have termed the "Lone Ridge fault" (Schmoll and others, 1981). Bedrock crops out only in a few places, the sedimentary rocks mainly in bluffs along the Chuitna River in the southwestern part of the map area, and the plutonic rocks mainly in the scarp that marks the position of the Lone Ridge fault We did not examine the bedrock in detail, and the information presented here is derived largely from Barnes (1966) as modified in Magoon and others (1976), and from Detterman and others (1976). We did not map coal beds exposed in places along the Chuitna River; emendation of the original mapping of Barnes (1966) is dependent largely on proprietary data being developed during exploration for coal (Patsch, 1975; oral communs., 1977-82; Ramsey, 1981; R. B. Sanders, formerly of Diamond Alaska Coal Company, oral The bedrock is covered in most of the area by a variably thick sequence of glacial moraine and outwash deposits that have been eroded and modified mainly along

stream channels, where they have been replaced or covered at the surface by a series of minor alluvial and colluvial (including landslide) deposits. The glacial deposits are in turn overlain locally by pond and bog deposits. Our mapping efforts have focused mainly on these surficial deposits. This map, at a scale of 1:31,680, was prepared from a photographic enlargement of both topography and geology that were originally compiled at a scale of 1:63,360. The enlargement was made to permit greater legibility than would be possible at the smaller scale. The level of detail and precision of both location and identification of map units presented here are, however, more nearly commensurate with the smaller scale, although some additional details have been included here that would not have been feasible The two cross sections that accompany the map are intended primarily to show the relationships among the surficial deposits as we interpret them. The surface profile was obtained by photogrammetric methods, but there are few data on which to base the subsurface interpretations. The cross sections portray our initial expectation of relationships of the units at depth based on their surface expression. Most of our surface observations, as

well as drill-hole data from just west of the map area (Odum and others, 1986), suggest that the surface deposits in most places are relatively thin and underlain by Tertiary bedrock rather than by a complex of older Pleistocene deposits. We know from scant evidence in adjacent quadrangles to the south and west that older glacial deposits are present locally beneath those at the surface, but since we do not know the distribution of any such deposits within the map area, they are not shown on the cross sections. The faults that appear on the geologic map are shown on the cross sections, with relative movement and attitudes based on the model of Hackett (1977, pl. 3) discussed below, mainly in order to indicate the nature of faulting that probably is present. However, neither lithologies nor structures within the Tyonek Formation are shown, because we have no reliable way of extending our data from the drill

hole to the west into the map area and published information is scant. MORAINE DEPOSITS Glacial deposits are mapped in terms of the informally named moraines that have been identified in this part of the Cook Inlet region in the course of our studies. We gave a brief description of our usage (Schmoll and Yehle, 1983), and that has been further elaborated for the moraines on the vest side of Cook Inlet in Schmoll and others (1984) and more fully in Schmoll and Yehle (1986). Seven of the principal moraines that we have identified converge within the area of this map, as summarized in igure 3. Of these, the Denslow Lake', Seven-thirty lake, Eight-ten lake, and Blueberry hill moraines take their names from features in this part of the quadrangle. Only Denslow Lake is a formal geographic name; we identified the other lakes by their elevation (in feet) as printed on the topographic map, whereas the Blueberry hill moraine takes its name from a small airstrip so called by local pilots and coal-exploration personnel. The Threemile Creek moraine is named from a stream east of the map area (fig. 1); the Nikolai moraine is named from a bench mark and the Fourteenoh-five lakes moraine from the elevation of a group of lakes, both features several kilometers west of the map area. In addition, the map includes a small area of Upper Chuitna ground moraine that occupies extensive areas just to the west where it borders the upper Chuitna River valley. These moraines are the products of glaciers that clearly had three different source areas (fig. 4). glaciers invaded the map area at different times, but the temporal relationships are somewhat ambiguous. The Blueberry hill and Threemile Creek moraines were deposited by glaciers that flowed southward down the Susitna lowland from the Alaska Range to the north, filling most of the upper part of the Cook Inlet region, and dominating the ice from closer, western sources so that it could not enter the map area. The Blueberry hill glacier was apparently the more extensive of the two, its margin situated at a higher level. It probably split into two lobes and occupied both sides of the Susitna highland, whereas the lower Threemile Creek glacier probably was restricted only to the lower lying east side of the highland. The Blueberry hill moraines are represented here by two fairly well developed lateral moraines, clearly recognized only in this vicinity. The Threemile Creek moraines comprise well developed lateral moraines northeast of the map area, but are here represented only by remnants of ground moraine, the laterals presumably having been removed and(or) overridden by the younger glaciers that entered the northern part of The southwestern part of the map area is dominated by the bold Nikolai lateral moraine, which had its source to the west in the Chakachatna valley, with contributions from the Tordrillo Mountains and from the Alaska Range beyond. Just north of this moraine are ground moraine remnants identified as part of the slightly higher and more extensive Fourteen-oh-five lakes moraine of the same source. Immediately to the west a well-developed lateral moraine is present, but within the map area itself there are only ground moraine remnants, some of which could be related alternatively to either the Blueberry hill moraine or the Threemile Creek moraine. The Nikolai moraine is probably younger than either the Blueberry hill moraine or the Threemile Creek moraine because it seems to truncate them. indicating that Nikolai ice was able to penetrate the map area and produce a well-developed lateral moraine only because the larger glaciers from the north were no longer present. The Fourteen-oh-five lakes moraine may be contemporaneous with the Threemile Creek moraine or, alternatively, with the Blueberry hill moraine, having been deposited when glaciers from northern and western sources merged. The Denslow Lake, Seven-thirty lake, and Eight-ten lake moraines are the products of glaciers that had a more northern, exclusively Tordrillo Mountains, source in the headwaters of the Beluga River valley where the extensive Capps and Triumvirate Glaciers are still present. This lobe apparently was strongly constrained by Lone Ridge, which forced the ice to swing sharply around its northeast end at the north edge of the map area. The youngest of these glacier advances produced the Denslow Lake moraine, a prominent lobate moraine that is well developed in the Tyonek B-4 quadrangle, just to the north of the map area (Yehle and Schmoll, unpublished mapping). In this map area, and well evidenced by moraines found mainly here, two preceding glacier advances followed a similar course, but extended farther south into the central part of the map area, producing the older Seven-thirty lake and the stillolder Eight-ten lake moraines. In both cases the ice flow was seemingly restricted by a hill that rises to more than 275 m in elevation (E1/2 sec. 7, T. 13 N., R. 11 W.). Each succeeding glacier advance may also have been prevented from advancing farther southward by the moraine left by the preceding glacier. The Denslow Lake, Seven-thirty lake, and Eight-ten lake moraines are clearly younger than the Blueberry hill and Threemile Creek moraines, which they seem to override. Originally, we thought of the Nikolai and Denslow Lake moraines as probably being contemporaneous because of their similarly well developed and preserved

discussed briefly below, it now seems more likely that the

contemporaneous and that the Seven-thirty lake and Denslow

The geomorphologic relationships of the moraines

differences among these moraines. A radiocarbon date of

13,820 yr B.P. (before present) from basal peat along the

east bank of Lone Creek in the northeastern part of the map

area (fig. 5) indicates that the youngest outwash from the

surmise that the Denslow Lake moraine, the youngest of the

moraines in the map area, may be at least 14,000-15,000 yr

old. It is thus older than the morphologically comparable

Elmendorf Moraine at Anchorage, about 80 km to the east,

"Carlson Lake moraine" (Schmoll and others, 1981).

which is radiocarbon-dated as about 13,000 yr old (Schmoll

¹The Denslow Lake moraine was initially called the

Denslow lake moraine is older than that date. From this, we

ggests that the relative ages outlined above are generally

Nikolai and Eight-ten lake moraines are approximately

correct, but we have little evidence for absolute age

Lake moraines are somewhat younger.

discontinuously preserved terraces within the incised valley of the Chuitna River and its tributaries. The alluvium is subdivided into nine units on the basis of age, morphology and texture. Most of this alluvium is probably of Holocene age, as suggested by the fact that the highest terrace along the Chuitna River is easily traceable to a locality near the river mouth where a radiocarbon age of 6,690 ± 110 yr (W-4409, Meyer Rubin, written commun., 1979) has been obtained for basal peat overlying this unit. Colluvium is mapped mainly along the steep walls of the incised valleys of the Chuitna River and its tributaries. Much of this colluvium is derived from the morainal deposits that are subject to erosion on the upper slopes of the valley walls. Such colluvium is a relatively thin veneer over the underlying soft Tertiary bedrock, which may be a major constituent of the colluvium. In many places bedrock can be found by excavating the colluvium, as was done in 1983 by the Diamond Alaska Coal Company along Lone Creek at coal exploration pits 2 and 3, in obtaining large samples of coal for testing purposes. In places, such as along the margins of hills of the Eight-ten lake moraine, the slopes have been modified sufficiently that we mapped them as colluvium derived from the moraine mostly by slumping and other gravitational processes. The fact that such colluviation is restricted mainly to the Eight-ten lake moraine suggests that it might be substantially older than other moraines (the Seven-thirty lake and Denslow Lake) from the same source. The Eight-ten lake moraine, lacking the coarse boulders found in the presumably coeval Nikolai moraine, might be more easily eroded than the Nikolai. Landslide deposits, which we regard as a type of colluvium, are not common within this map area, although they occur widely elsewhere on the Beluga plateau (Yehle Schmoll, and Chleborad, 1983a, 1983b; Schmoll and others, 1984) associated with the relatively weak rocks of the Tyonek Formation (Odum, 1984; 1985), exposures of which are restricted mainly to the valley walls along the Chuitna River. Some of these relatively small slides are probabl fairly old, but the one at the south edge of sec. 9, T. 12 N., R. 12 W., occurred about 1979; continued slide development can be expected from time to time in similar We have not dated any of the colluvial deposits directly, and most of them are presumed to be mainly Holocene in age, but some, especially those developed on the older moraines, may well have begun to form during late Pleistocene time. The shallow depressions in the generally irregular surface of most morainal deposits, as well as some relatively low areas on the alluvial surfaces, are or have been occupied by ponds in various stages of being filled in by plant growth. The resulting bogs consist mainly of peat and vary considerably in degree of wetness. Those bogs or parts thereof that appear relatively wetter or drier than most are mapped separately. The bogs also include many variably continuous beds of mostly ash-size tephra from volcanoes to the northwest, west, and southwest (Riehle, 1985). The relatively thick accumulations of peat containing thin interbedded tephra in the areas mapped as bog and pond deposits grade laterally away from the bogs into a complex of tephra deposits with thin organic interbeds. This complex constitutes a ubiquitous blanket 1 m or less in thickness that, although not mapped, covers all of the glacial deposits and, to an extent roughly commensurate with age, the older alluvium and colluvium as well. The bog deposits are mainly Holocene in age, but several in and adjacent to the map area have yielded basal radiocarbon dates in the range of 10,000-14,000 yr B.P. In addition to the bog deposits discussed above in relation to the Denslow Lake moraine and its outwash trains, and illustrated in figure 5, one other bog within the map area. at coal exploration pit 1, has yielded a basal radiocarbon age of $10,140\pm150$ yr (I-12,376), placing the lowest beds just within the uppermost Pleistocene. The two dated bogs within the map area illustrate, however, that the ages of basal peat beds in bogs do not necessarily correlate directly with ages of the underlying moraine or outwash deposits. The basal peat bed that dates older overlies deposits that on morphological grounds have to be younger than the deposits underlying the basal peat bed that dates younger. Consequently it appears that bogs began forming at various times following the deposition of the underlying deposits. Other bogs within the map area, from which we do not have dates, probably vary in age, but many may well have begun to form during late Pleistocene time. state; however, mainly because of the relationships among their respective outwash trains as portrayed on this map and

it southwestward, we are inclined to regard it more as one in a series of en echelon faults that includes both the Castle Mountain and the Lake Clark fault systems without necessarily implying direct linear connections between them; this interpretation can be inferred also from the maps in Grantz and others (1963) and in Hackett (1977). The Lone Ridge fault is expressed as a narrow linear zone of sheared and disintegrated granodiorite that is exposed in a well-marked, southeast-facing scarp about 25 m high and is spectacularly visible from a considerable distance. As noted by Detterman and others (1976), there are several springs along this line, and a linear depression containing numerous ponds parallels the fault on its southeast side. The fault separates the granodiorite on the orthwest side from the Tyonek Formation to the southeast, implied differential movement being up on the northwest side, estimated by Detterman and others (1976) to be on the order of 500-1,000 m. We have little evidence to determine the attitude of the fault, but concur with those authors that it is probably a reverse fault. From our mapping of the moraines with respect to this fault, it appears (1) that the fault displaces the Blueberry hill moraine, all of the moraine apparently having been eroded from the upthrown, topographically higher, side; (2) that the Seven-thirty lake moraine and, by inference, the overridden Eight-ten lake moraine, are probably displaced, to lesser extents; and (3) that the Denslow Lake moraine is clearly not displaced. All surface expression of the fault Denslow Lake moraine, and nowhere to the northeast does one find surface evidence of a fault along this trend. If these morphologic interpretations are correct, this fault (1) was active following deposition of the Blueberry hill moraine, 2) may have continued to be active during the time of the Eight-ten lake and Seven-thirty lake moraines, and (3) had ceased activity by the time of deposition of the Denslow Lake moraine, that is, probably before about 15,000 yr ago. Some caution in these interpretations is necessary, The other principal glacier-related deposits of the map however. We do not know the nature or configuration of the Blueberry hill moraine north of the fault, in large part because that area is occupied mainly by the younger Denslow Lake moraine. Furthermore, surface evidence of the fault is observed only where the granodiorite body is present, and we may be seeing merely a fault-line scarp caused primarily by differential erosion at the contact between the granodiorite and the much softer rocks of the Tyonek Formation. In this case no inference can be made about the age of the fault activity. If the age relationship of the fault to the moraines outlined above is valid, however, the magnitude of the fault scarp implies a substantial age difference between surrounding ice-deposited moraine. Outwash-channel deposits the Blueberry hill and the Denslow Lake moraines. Although the absolute age is conjectural, a longer period of time could be involved than would permit including both moraines within a single late Pleistocene glaciation. About 3 km southeast of the Lone Ridge fault we show a concealed fault as proposed by Ramsey (1981), on the basis of subsurface data developed during coal exploration. Subsequent exploration may add other faults (Ramsey, 1981; R. B. Sanders, formerly of Diamond Alaska Coal Company, oral commun., 1982). That such faults should exist is expectable, for example, from the model of Hackett (1977, pl. 3). Two additional faults farther southeast are also taken from Ramsey (1981). The more northwesterly is an interpolation between faults mapped by Barnes (1966) from exposures along the Chuitna and Beluga Rivers southwest and northeast of the map area, respectively. The other fault. labeled Moquawkie fault by Ramsey (1981), is probably one interpretation of the fault inferred by several workers to extend from the Bruin Bay fault far to the southwest, through a complex of numerous faults identified in subsurface data developed from offshore oil exploration (Boss and others, 1976), to join the Castle Mountain fault farther northeast. The position of such a fault coincides in part with the Moquawkie magnetic contact of Grantz and others (1963), and we, like Ramsey (1981), continue use of this terminology, further considering that the several possible northeast-trending faults in the southeastern part of the map area constitute the Moguawkie fault zone. The Moquawkie fault zone may mark the contact between the Beluga and Tyonek Formations, as shown, for example, by Magoon and others (1976). However, others working along the incised valley of the Chuitna River have left this open to question. For example, Detterman and others (1976) map the Beluga Formation farther up the valley, whereas Turner and others (1980) indicate the presence of Seldovian fauna (indicative of all but the lowermost part of the Tyonek Formation) in rocks farther down the valley. We infer that greater structural complexity is likely in the area of the Moquawkie fault zone than has yet been reported. Proprietary seismic and coal-exploration data may ultimately provide more definitive information than is presently available. We have no surface evidence that bears on the location or nature of these largely inferential faults. Although some surface features may be found to align with parts of these inferred faults as shown here, such coincidence is not compelling enough to be regarded as more than fortuitous. Consequently, we believe that there has been no activity on these faults or related structures in late Pleistocene or

connecting two better documented faults--the Castle Mountain

this fault northeastward, and very little evidence to extend

fault to the northeast and the Lake Clark fault to the

southwest. Because we find no surface evidence to extend

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Denslow Lake Seven-thirt Eight-ten Nikolai moraines Threemile Creek moraines Blueberry bmg hill moraine

Moraine deposits

SURFICIAL DEPOSITS Bog, pond, and Residual Colluvial and landslide deposits lake deposits deposits Alluvial deposits Pleistocene \ Miocene and ∫ 01 igocene TERTIARY AND Ground-moraine deposits of Fourteen-oh-five lakes

CORRELATION OF MAP UNITS

Glacioalluvial deposits

moraine (Pleistocene) -- In areas adjacent to

end moraine and Nikolai lateral moraine.

Occupies relatively large areas of gently

Chuitna River and area between Eight-ten lakes

rolling topography that includes scattered, but

relief about 1.5 m. Not readily distinguishable

moraine to north, or from Threemile Creek ground

deposits contain volcanic phenoclasts like those

thought to be related to Fourteen-oh-five lakes

lateral moraine of similar provenance, the type

of Nikolai lateral moraine (although generally

in lower concentrations) and consequently are

area of which is about 8 km west of map area.

Ground-moraine deposits of Threemile Creek moraine

look like northeast-trending drumlins, a

ortheast and thus a Susitna lowland-Alaska

Range provenance. Thickness at least 5 m

(Pleistocene) -- In generally rolling terrain

from land occupied by Blueberry hill lateral

relief about 2.3 m. Dissected locally with

is located, outside Blueberry hill lateral

Subdivided into seven units that occur in series

surface of channel now drained by East fork of

on east side of Middle creek itself near south

Second-oldest unit--Emanates from southernmost

diverges southward, becoming intermediate

a high level of ancestral Cook Inlet

terrace along Middle creek, with a possible

point of end moraine. Occurs as slightly lower

of two high terraces along upper Lone Creek, but

divergence westward into Lone Ridge creek and a

further divergence from modern drainage to form

edge of map area

Middle creek, farther south forming high terrace

moraines. Deposits probably of western

relief of about 20 m by major western

(Pleistocene) -- In widely dissected, low, rolling

hickness at least 5 m

from either south end of Blueberry hill ground

moraine to east. In a few places, however,

relatively large, bogs and a few ponds. Mean

ANCHORAGE LOWLAND & FIRE POSSESSION Figure 1.--Map of upper Cook Inlet region showing relationship of northwestern quarter of Tyonek A-4 quadrangle (lightly outlined rectangle) to selected physiographic and geographic

DESCRIPTION OF MAP UNITS The map delineates deposits thought to be about 1 m or more in thickness. Grain-size terminology for surficial deposits follows that of the Wentworth grade scale (American Geological Institute, Data Sheet Committee, 1958). All hicknesses given for deposits are estimates. The age symbol Q is omitted from Quaternary deposits, but other standard age symbols are used for pre-Quaternary rocks.

> SURFICIAL DEPOSITS Moraine Deposits

Subdivided according to the individually named moraines summarized on figure 3, and according to the following types of moraines: End and lateral moraines are well-defined, fairly continuous belts of hummocky topography of generally high relief, commonly dotted with numerous ponds and other ndrained depressions, that mark the marginal position of a ormer glacier. These two types of moraine commonly grade into one another, and the division between them is somewhat arbitrary; here, the designation "end moraine" is used for segments that clearly form part of a lobate configuration. hereas the more nearly linear margi which do not lead to preserved end-moraine lobes, are identified as lateral moraines. Hummocky moraines are less well defined areas of moderately high relief that lie within the area bounded by the end and lateral moraines and are found a short distance upvalley from end moraines; some of hese areas have a smoother surface than the surrounding terrain but rise well above it. Ground moraine constitutes the areas within the morainal belts that have relatively low relief and generally thinner deposits and that are commonly found well upvalley from the end moraines. Estimates of mean relief given below for principal moraine units have been derived statistically from elevations determined by photogrammetric methods from random profiles across map All moraines composed chiefly of till, commonly a diamicton consisting of unsorted to poorly sorted gravelly sandy silt and variable, commonly lesser, amounts of clay; clasts as large as boulders; locally includes well-sorted. discontinuous lenses of sand and sandy pebble gravel.

oderately compact. Includes some kame, channel outwash.

END- AND LATERAL-MORAINE DEPOSITS--In broadly lobate

alluvial, and bog-and-pond deposits too small to map

separately at 1:31,680 scale

presumably older, however, than any other to linear hummocky ridges and ridge remnants moraines of map area, as all of them seem to having variable but relatively high relief in converge on apparently pre-existing areas of the form of many irregular, steep-sided hills this drift. Occurs in generally flat lying, and intervening depressions. The diamicton may broad areas that include lakes and ponds, as contain a high percentage of coarse clasts. well as extensive areas of bogs of which only a hickness variable, may be 25 m or more in bit of a few extend into the western part of map higher parts, substantially less beneath area. Thickness 5 m or less depressions End-moraine deposits of Denslow Lake moraine (late Pleistocene) -- In a prominent lobate ridge in Glacioalluvial Deposits northeastern part of map area; consists of many sharp hills and intervening depressions, most KAME AND ESKER DEPOSITS OF DENSLOW LAKE MORAINE occupied about equally by lakes, ponds, or bogs. (LATE PLEISTOCENE) -- Mostly gravelly sand; some Mean relief about 4 m. This moraine is gravelly, silty sand, and diamicton. Most southernmost part of large morainal lobe that is deposits loose, some relatively compact also well developed north of map area (Yehle. Kame deposits--In irregularly shaped hills of Schmoll, and Chleborad, 1983a, 1983b; Yehle, generally low relief that occur locally within Schmoll, and Gardner, 1983; Yehle and Schmoll end moraine and that formed after ice margin unpublished mapping) and that here includes the became stagnant. Thickness probably less than informal type area of the moraine in the vicinity of Denslow Lake. Also includes, in Esker deposits--In a single esker, an elongate, northwest corner of map area, a small area where slightly sinuous hill of relatively high relief the Denslow Lake moraine has characteristics of that is within bounds of end moraine and that both end and lateral moraines stands above adjacent areas of hummocky

End-moraine deposits of Seven-thirty lake moraine moraine. Thickness probably at least 15 m (late Pleistocene) -- In massive lobate ridge OUTWASH-CHANNEL DEPOSITS--Mostly bedded sandy remnants just south of, and outside, the Denslow gravel, gravelly sand, and sand. Most deposits Lake moraine that are dissected, especially in loose and moderately well sorted; may be more the central part, by outwash from that gravelly at depth. Commonly overlain by bog and moraine. Contains many depressions, more of pond or other organic deposits; where these are extensive and more than about 1 m thick, mapped them occupied by bogs than by lakes and ponds. Mean relief about 2 m. The region around the separately as pond and bog deposits. Thickness largest of the several lakes, identified by its probably less than 5 m 730-ft elevation, is used as the informal type Deposits of Denslow Lake moraine (late area for this moraine. Apparently overlapped by Pleistocene) -- In northeastern part of map area Denslow Lake moraine near east edge of map area, in irregularly shaped channels in low-lying Seven-thirty lake moraine continues northward as areas between hills of hummocky moraine near. an irregular belt just east of Denslow Lake and north of, Denslow Lake moraine (Yehle and Schmoll, unpublished mapping) Deposits of Eight-ten lake moraine (late Lateral-moraine deposits of Seven-thirty lake Pleistocene) -- In western part of moraine in small channels and terrace remnants that are, at moraine (late Pleistocene) -- In narrow linear ridge on northwest flank of Lone Ridge that is least in part, lower and younger than youngest more subdued than, but appears equivalent to, outwash-train deposits; in eastern part of Seven-thirty lake end moraine, judged by its moraine they drain into areas of Threemile Creek moraine. Similar such channels are now occupied position south of Denslow Lake moraine in and entirely by bog and pond deposits and are so west of northwest corner of map area End-moraine deposits of Eight-ten lake moraine (late Pleistocene)--In highly dissected remnants Deposits of Nikolai moraine (late Pleistocene) -- In of a large lobate ridge that occupies central southwestern part of map area in irregularly part of map area. Largest remnants are shaped channels in low-lying areas between hills hummocky, include a few lakes and several large of ground moraine south of Nikolai lateral bogs; smaller remnants are somewhat hummocky but free of lakes and bogs large enough to map at Deposits of Fourteen-oh-five lakes moraine 1:31,680 scale. Mean relief about 2.4 m. (Pleistocene) -- In small channel remnant within ground moraine that is now truncated by outwash Overlapped by Seven-thirty lake moraine in eastcentral part of map area, this moraine not known associated with Seven-thirty lake moraine to be represented farther north, although it may Deposits of Blueberry hill moraine (Pleistocene) -be present there but not distinguishable from In western part of map area in well-defined Seven-thirty lake moraine southwest-trending channels that lie between Lateral-moraine deposits of Eight-ten lake moraine ridges of lateral moraine or were cut into (late Pleistocene) -- In single linear ridge that ground moraine and that parallel the regional is higher on northwest flank of Lone Ridge and OUTWASH-TRAIN DEPOSITS (LATE PLEISTOCENE) -- Chiefly somewhat more massive than younger Seven-thirty lake lateral moraine. Identified chiefly by its well-bedded gravel, sandy gravel, and gravelly position, this lateral moraine is also subsand. Most deposits loose and generally well stantially more subdued than its presumed endsorted. These are principal deposits within map moraine equivalent area likely to provide significant sources of Lateral-moraine deposits of Nikolai moraine (late sand and gravel for construction purposes. Pleistocene) -- In east end of bold, continuous Thickness probably 5-7 m; locally may be thickridge having mean relief of about 2.6 m that is in southwestern part of map area, where it thin or lacking, as at coal exploration pit 1. grades into series of moraine remnants and kame Deposits associated with Denslow Lake moraine-complexes that extend southeastward beyond map

area. Volcanic phenoclasts, including a relaof terraces at successively lower levels (fig. tively high percentage of boulders, many of them 6), corresponding to changes in source location angular, are dominant at many places within this within glacier and(or) to changes in base level. moraine; clasts possibly derived from volcanic and that are thought to be successively younger activity on Mount Spurr, to which lateral morin age. Because no more than three of these units occur in any one sequence of terraces, and aine can be traced; boldness of moraine may be because all units are discontinuously preserved, result of exceptional coarseness of many clasts sequence of units presented on map is in moraine. Lakes, ponds, and bogs common provisional and subject to further refinement Lateral-moraine deposits of Blueberry hill moraine Youngest unit -- Seems to emanate from outwash (Pleistocene) -- In prominent, high-lying linear ridges that extend southwesterly in and west of channels within moraine near Denslow Lake, and occurs as a low terrace along Lone Creek. A western part of map area for about 9 km between radiocarbon date of 13,820 yr B.P. was obtained Lone Ridge, near where informal type area is from deposits overlying this unit in SW1/4SW1/4 located, and vicinity of Chuitna River. sec. 13, T. 12 N., R. 12 W. (fig. 5) Depressions along ridges contain some bog Sixth-oldest unit--Originates in channel cut deposits, but generally these ridges are less lower than level of end moraine west of its hummocky and more massive than other lateral southernmost point. Occurs as intermediate moraines within map area. Mean relief about 3.6 terrace along upper part of Lone Creek, but m. Highly dissected in places; elsewhere farther downstream, mainly east of map area, eposits overlapped by colluvial or debris-flow deposits derived from Lone Ridge. At northeast becomes main surface of broad channel occupied by Lone Creek end of moraine there are two distinct ridges, Fifth-oldest unit--Apparently emanates from near but southwestward they merge; inner ridge not southernmost point of end moraine. Occurs as thought to mark any significant break in glacial intermediate terrace along upper part of Lone deposition or marked retreat and readvance of Creek, diverging southward, however, to become low terrace along most of Middle creek, and then HUMMOCKY MORAINE DEPOSITS--Diamicton in landforms splitting near south edge of map area to form a having uneven surface topography generally now-abandoned, bog-filled channel west of modern resembling that of end moraines but having Middle creek somewhat less relief and little linear Fourth-oldest unit--Not presently found in continuity; generally occur inward from end direct association with end moraine. Occurs in moraines. Thickness may be as much as 25 m high terrace remnant along Lone Creek that Hummocky moraine deposits of Denslow Lake moraine appears to correlate with lowest level of (late Pleistocene) -- In area north of end moraine that consists of many hills of diamicton with channel now beheaded by Lone Creek valley and mean relief of about 3.3 m; dissected by many drained by East fork of Middle creek, ultimately plitting into two small channels farther south intervening outwash channels and kames Hummocky moraine deposits of Eight-ten lake Third-oldest unit--Not presently found in direct association with end moraine. Occurs as major moraine (late Pleistocene) -- In scattered moraine

remnants that rise notably higher than adjacent

comparable distribution of generally large bogs

and relatively few, but fairly large, ponds.

Hummocky moraine deposits of Nikolai moraine (late

Pleistocene) -- In a single moraine remnant, part

of a group that is more extensive south of map

area and that seems to be a less well developed

continuation of the lateral moraine, forming

part of an interrupted series of massive kames

in areas between hills. May overlie older

glacial deposits locally, some of which not

readily distinguishable from surface deposit.

areas of ground moraine, but include a

Mean relief about 1.5 m

a major independent terrace near south edge of and morainal hills. Mean relief about 1.5 m. map area, continuing southward to lower reaches It is likely that in this vicinity Nikolai glacier was invaded by outwash from adjacent of Tyonek Creek Oldest clearly recognized unit--Emanates from ight-ten lake glacier just to the north western side of end moraine near point where it Hummocky moraine deposits of Threemile Creek leaves Lone Ridge, and forms a small outwash moraine (Pleistocene) -- In southwesternmost part plain. Some drainage appears to have been by of group of moraine remnants in informal type valley of Lone Ridge creek, but most deposits area east of map area; these remnants rise from such drainage are not now differentiable higher in elevation than adjacent ground moraine GROUND-MORAINE DEPOSITS--Diamicton forming rolling from younger alluvium. Major part of this unit forms highest terrace along Middle creek and hills of generally low relief that are dissected probably constituted initial stages in formation into remnants bordered by areas of relatively of this valley. It diverges from modern steep slope and higher relief drainage in southern part of map area to form Thin ground-moraine deposits of Denslow Lake now-abandoned channel that is interrupted by moraine (late Pleistocene) -- Thin deposits Chuitna River, but that seems to continue overlying bedrock that may be exposed locally on southward as terrace along Tyonek Creek dissected margins of hill that constitutes Deposits associated with Seven-thirty lake single occurrence of this map unit at north edge moraine--Subdivided into two units present now of map area; widely distributed in next quadas remnants scattered about much of central part rangle north. Thickness probably less than 2 m of map area (fig. 6) Ground-moraine deposits of Seven-thirty lake Younger unit--Emanates from western side of end moraine (late Pleistocene) -- Occupies relatively moraine near Lone Ridge, and perhaps from low lying areas north of Lone Ridge and adjacen farther south along moraine as well. Occurs as to Seven-thirty lake lateral moraine. To east, (1) a channel adjacent to, and partly within. on north end of Lone Ridge, deposits may be thir moraine that then becomes low terrace in broadly or even lacking, granodiorite covered instead by meadering channel in center of map area and (2) residual deposits (r). Thickness about 5 m as low terrace along upper reaches of Lone Ridge Ground-moraine deposits of Eight-ten lake moraine creek; these two elements join to form low (late Pleistocene) -- In dissected rolling hills terrace along lower Lone Ridge creek. It is in central part of map area within Eight-ten possible that at least some elements of this lake end moraine. Relatively large bogs and a drainage system may relate instead to Denslow few lakes common in some areas, but lacking in Lake moraine as part of oldest drainage from others where topography is somewhat smoother. that moraine Mean relief about 1.4 m. Thickness about 5 m; Older unit--Emanates mainly from now-dissected in northwest corner of map area, on northwest central part of end moraine. Occurs as (1) high slope of Lone Ridge, diamicton probably thinner, terrace along lower reaches of Lone Ridge creek in part colluviated, and underlain by deposited by streams that may have also occupied granodiorite upper part of that creek valley and that Ground-moraine deposits of Nikolai moraine (late probably initiated broadly meandering channel in Pleistocene) -- In low-lying hills in southwest corner of map area south of Nikolai lateral plain in east-central part of map area that moraine. A few bogs and lakes occur within these gently rolling hills, but are more common drained mainly southeastward, perhaps graded to

Deposits associated with Eight-ten lake moraine--Subdivided into two units that emanate from various points around the moraine (fig. 6) Younger unit--Emanates from within western and eastern parts of moraine. Occurs as remnants of high-level channel systems that drained southwestward into areas of Blueberry hill ground moraine, but that may then have constituted an early phase in development of Chuitna River in area between Eight-ten lake and Nikolai moraines Older unit--Emanates from southern part of end moraine. Occurs as single unit that is remnant of outwash plain whose former extent is unknown, but which also may have been graded to high level of ancestral Cook Inlet Deposits associated with Nikolai moraine--A small outwash plain that extends east from moraine into a channel across Fourteen-oh-five lakes ground moraine and that is presently truncated by Chuitna River canyon; may have been coextensive with Eight-ten lake outwash plain Alluvial Deposits

hills in eastern part of map area. Ponds and bogs not common, but a few large bogs present locally. Mean relief about 1.3 m. Some hills ALLUVIUM ALONG MODERN STREAMS characteristic that is more distinct northeast Deposits within active floodplain of Chuitna River of map area, presumably reflecting ice-flow from bedded and sorted, in bars and very low terraces Ground-moraine deposits of Blueberry hill moraine that are subject to continual reworking by the river and generally not covered by vegetation. having dominantly southeastward regional slope Thickness may be only a few meters or less; bedrock common in river bed, exposed during low moraines. Ponds and bogs fairly large and more water stages Deposits in lowest terraces along all major numerous in southern part of this map-unit area, streams (Holocene)--Chiefly pebbly sand and but small and uncommon in northern part. Mean sandy gravel, well bedded and moderately well to well sorted within beds. Thickness possibly as much as 15 m, commonly less; bedrock may occur tributaries of Lone Ridge creek. Also includes, at shallow depth especially along Chuitna River mainly by inference, ground moraine on hill in Fine-grained deposits in valley bottoms and lowest northeastern part of map area that rises above terraces along low-gradient creeks (Holocene) --Denslow Lake and Seven-thirty lake moraines and Chiefly sand, fine-grained sand, and silt, that was covered by glacier higher than that of moderately well bedded and sorted; may be of Threemile Creek moraine. Thickness at least 5 m lacustrine origin in part. Commonly overlain by Ground-moraine deposits of Upper Chuitna moraine organic deposits. Occurs mainly in upper (middle(?) Pleistocene) -- In small area at west reaches of creeks tributary to Chuitna River. edge of map area; much larger areas of this unit Thickness 5 m or less occur just west of here where informal type area Deposits in intermediate terraces along Chuitna River (Holocene) -- Chiefly gravel and sand, wel bedded and sorted within beds. Thickness 5-10 provenance. Age of this drift and configuration m, but may be underlain by bedrock at shallow of glacier that deposited it is uncertain: it is depth in places Deposits in high terraces along Chuitna River (early Holocene) -- Chiefly gravel and sand, well bedded and sorted within beds. Commonly has relatively thick cover of peat and tephra. Thickness 5-10 m, but may be underlain by bedrock at shallow depth in places ALLUVIUM IN FANS AND CONES (HOLOCENE)

Coarse-grained deposits in alluvial fans--Chiefly sandy gravel and pebbly sand, moderately well, but possibly irregularly, bedded; moderately well to poorly sorted within beds. Occurs mainly where small streams debouch onto valley floors of major creeks, and at base of steep southeast side of Lone Ridge. Thickness variable, possibly as much as 10 m, but commonly less, especially in smaller fans Fine-grained deposits in alluvial fans--Chiefly sand and silt, irregularly bedded and moderately poorly sorted. Overlain by organic deposits. Present in only one place on gentle northwest slope of Lone Ridge. Thickness probably 5 m or Deposits in coalescent fans and cones--Chiefly sandy gravel, gravelly sand, silty sandy gravel, and possibly diamicton, irregularly to poorly bedded and moderately poorly to poorly sorted. Occurs on lower parts of valley walls, mainly along Chuitna River. Underlain by colluvium or bedrock. Thickness as much as 10 m in central part, perhaps as thin as 1 m near top and base Deposits in alluvial-colluvial cones--Probably sandy gravel and silty sandy gravel, perhaps including diamicton; poorly sorted. May be deposited, in part, by debris flows. Occur in places southeast of Lone Ridge where deposits overlie Blueberry hill moraine. Thickness may

Colluvial and Landslide Deposits (Holocene and Pleistocene) Colluvial deposits consist of irregularly mixed fragments of various sizes and types derived by weathering and gravity processes acting on older geologic materials. both surficial deposits and bedrock. They are generally unsorted and loose to moderately compact. Landslide deposits are developed mainly by gravitational failure along discrete buried surfaces in relatively soft sedimentary bedrock and include minor amounts of overlying surficial deposits as well. They resulted mainly from single slides along the walls of the incised Chuitna River valley.

MIXED DEPOSITS OF COLLUVIUM AND FINE-GRAINED ALLUVIUM--Chiefly silt, sand, and very fine to fine pebbly sand derived from disintegrated granodiorite in areas on northwest slope of Lone Ridge where deposits of minor watercourses are so intimately mixed with similar material that is dominantly colluvial in origin that both deposit types are too small and(or) indistinguishable to map separately at 1:31,680 scale. hickness may be as much as 5 m COLLUVIAL DEPOSITS DERIVED FROM MORAINES -- Chiefly diamicton similar to that of related moraines, but generally less compact; includes minor amounts of better sorted sand, silt, and pebbles in irregular beds. Occurs mainly on moderate slopes bordering hills of Eight-ten lake moraine. Thickness probably less than 5 m, but ay he thicker locally in gullie COLLUVIAL DEPOSITS ON VALLEY WALLS--Chiefly diamicton consisting of pebbly silt and sand, including also some clay, gravel, boulders, and bedrock fragments of various sizes; locally includes some organic material. Poorly bedded and sorted. Occurs mainly on steep slopes bordering Chuitna River and its tributaries Thickness 2-5 m, but thinner in places, especially higher on slope and in many areas of bedrock outcrop too small to map separately at 1:31.680 scale COLLUVIAL DEPOSITS RESULTING FROM LANDSLIDES--Chiefly diamicton consisting of gravelly silt and sand and relatively minor amounts of clay and some organic material. Includes boulders and some relatively large masses of bedrock. Generally nonbedded and poorly sorted: relatively loose. Queried where identity is somewhat uncertain. Thickness as much as 50 m

Blocky landslide debris--Occurs as single massive

the Chuitna River that probably includes very

deposit near confluence of Lone Ridge creek and

large blocks of intact sandstone, coal, and(or)

siltstone. Thickness at least 50 m Bog, Pond, and Lake Deposits (Holocene and Pleistocene) Chiefly peat (mosses, sedges, and other organic debris in various stages of decomposition) and organic silt that include minor woody horizons and numerous thin interbeds of mainly, ash-sized tephra, and that are accumulating in bogs; especially at depth, includes mainly fine-grained deposits (silt, clay, and fine- to medium-grained sand) containing relatively little organic matter laid down in ponds and small lakes that formerly occupied the sites of present-day bogs. Soft and moist. Occur throughout the map area except along top of Lone Ridge. Adjacent mapped deposits extend beneath these deposits. Thickness as much as 4 m DEPOSITS IN BOGS OF NORMAL WETNESS--Water commonly present at root level; includes some ponds, but few intervening areas of open water

levels within the vegetation mat; includes many ponds, some too small to appear on the base map, and many small areas of open water. May be somewhat thicker than other bog deposits, or may include higher proportion of pond and lake DEPOSITS IN DRIER BOGS--Water generally not present at root level; includes few ponds or other areas of open water and possibly thinner organic deposits than other bogs contain. May be underlain by coarse deposits such as gravel and sand, or otherwise be better drained than other bogs Residual Deposits (Holocene and Pleistocene) RUBBLE DERIVED MAINLY FROM GRANODIORITE--Includes some glacial erratics, eolian material, volcanic ash, and organic soil; grades downward to firm bedrock. Present only on Lone Ridge. This area

was probably covered by glacier ice at one or

more times during older glaciations, but little

evidence of these events, other than scattered

erratics, has been found. Thickness to intact

EPOSITS IN WETTER BOGS--Water present at higher

bedrock probably 2 m or less YONEK FORMATION (MIOCENE AND OLIGOCENE) -- Chiefly siltstone and claystone, carbonaceous siltstone and claystone, sandstone, and coal (Barnes, 1966; Odum and others, 1986). Mapped only in major outcrops along Chuitna River. Thickness about 1,000-2,000 m, thickening eastward (Hartman and others, 1972); probably less than 1.000 m toward the northwest. Oueried (on cross section) where may include similar rocks of the GRANODIORITE (EARLY TERTIARY OR LATE CRETACEOUS) --Mainly granodiorite (Detterman and others, 1976) or similar medium-grained equigranular biotite containing rock in one of a series of plutonic bodies exposed intermittently along northwest side of Cook Inlet basin. Where exposed along Lone Ridge fault, is generally a grus. This material, as well as nondisintegrated rock when crushed, may provide a source of aggregate for some construction purposes. Thickness unknown

---- CONTACT--Approximate, inferred, or indefinite FAULT--Probably reverse fault of relatively high angle; dotted where inferred and(or) RECLAIMED COAL EXPLORATION PIT--Numbers referred to in text X RADIOCARBON LOCALITY--Illustrated in figure 5

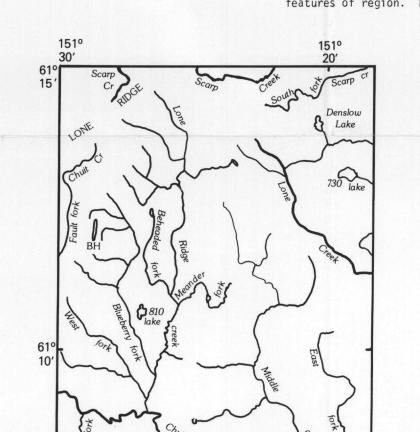


Figure 2.--Map of northwestern quarter of Tyonek A-4 quadrangle showing selected streams and other geographic features. BH, Blueberry hill airstrip. Named features shown by slightly heavier line than those unnamed; informal designations for the latter are not capitalized.

1 2 mi

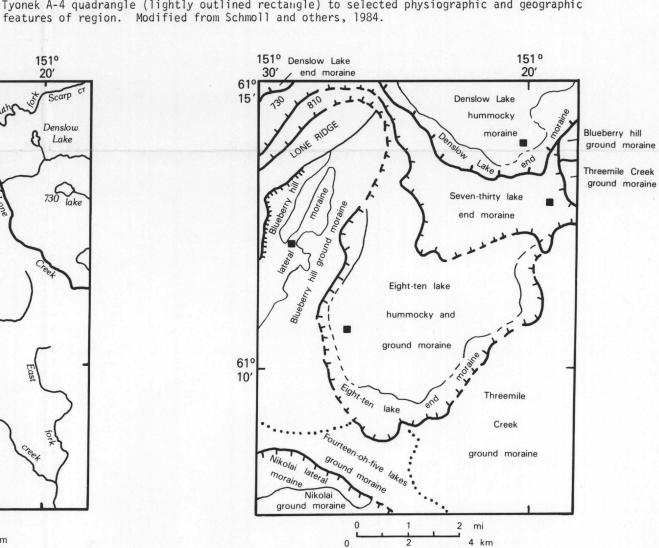
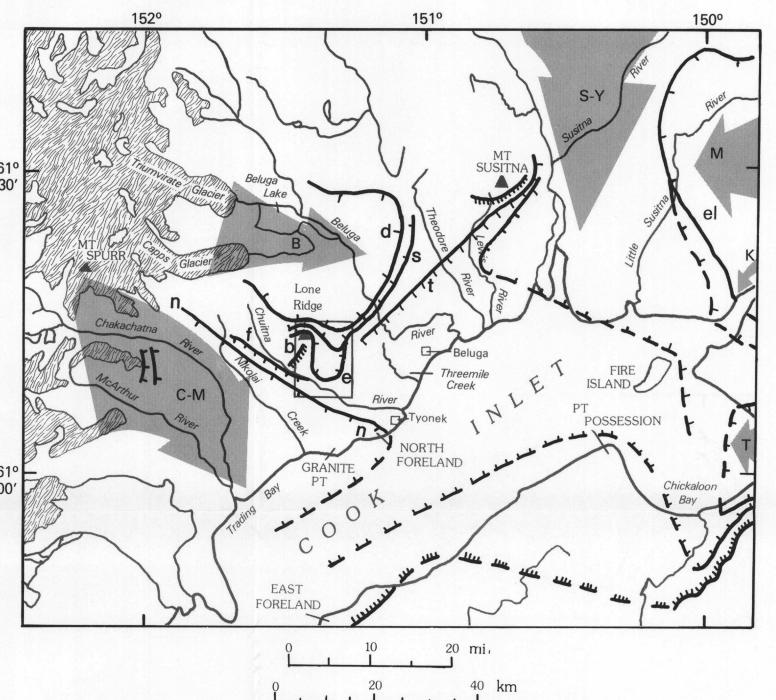


Figure 3.--Map of northwestern quarter of Tyonek A-4 quadrangle outlining principal named moraines. Bold lines indicate boundaries of end and lateral moraines, ticks on side toward glacier; dashed lines, inferred positions where moraines eroded; dotted lines, indefinite boundaries between ground moraines; solid squares, locations of features from which moraines were named.



GLACIOESTUARINE ASSOCIATIONS (GEA) INTO WHICH NAMED MORAINES MORAINES ARE GROUPED b Blueberry hill Cairn Point GEA d Denslow Lake Chickaloon Bay GEA e Eight-ten lake Fire Island GEA el Elmendorf Point Possession GEA f Fourteen-oh-five lakes n Nikolai s Seven-thirty lake t Threemile Creek

yr B.P., I-11,102.

GLACIER LOBES (SHOWN BY ARROWS) AND SOURCE Beluga, from Tordrillo Mountains C-M Chakachatna-McArthur, from Tordrillo and Chigmit Mountains, as well as Alaska Range farther west Knik Compound lobe from Chugach and M Matanuska J Talkeetna Mountains S-Y Susitna-Yentna, mainly from Alaska Range to north T Turnagain Arm, from Chugach and Kenai Mountains

Figure 4.--Map of upper Cook Inlet region showing principal moraines related to those in northwestern quarter of Tyonek A-4 quadrangle (lightly outlined rectangle), and indicating source areas and interpreted terminal positions for glaciers that deposited them. Moraines shown by bold lines, dashed where glacier inferred to have terminated in water, with ticks on side toward glaciers. Modified from Schmoll and Yehle (1986).

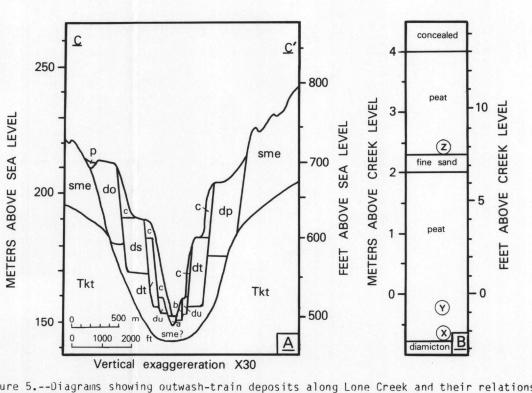


Figure 5.--Diagrams showing outwash-train deposits along Lone Creek and their relationship to radiocarbon-dated bog deposits, NW1/4SW1/4SW1/4 sec. 13, T. 13 N., R. 12 W. A, Hypothetical cross section along line <u>C-C'</u> on geologic map, showing terraced outwash-train deposits; b, bog deposits exposed in cutbank; p, pond and bog deposits at surface; other symbols as used on geologic map. Some units of colluvium (c), as well as bog deposits, that are shown on diagram are too small to appear on geologic map. Buried units are inferred from relationships shown on geologic map. All contacts inferred. B Generalized stratigraphic section through bog deposits; circled letters, locations of samples having radiocarbon ages and laboratory numbers (Isotopes, Incorporated) as follows: x, 13,820±170 yr B.P., I-13,072; y, 12,420±190 yr B.P., I-10,834; z, 9,230±140

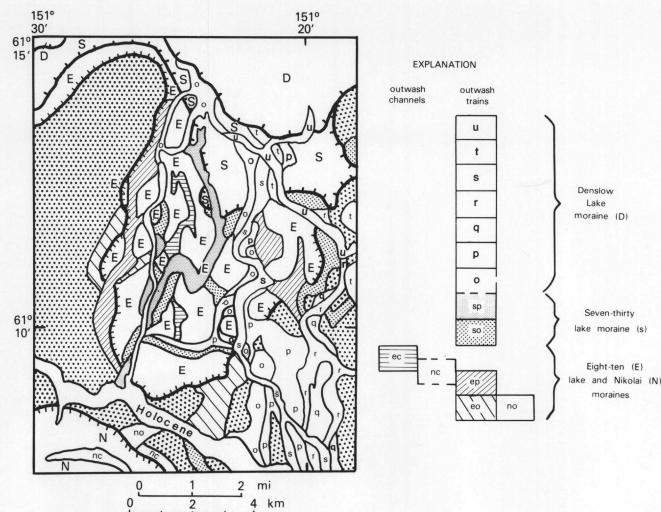
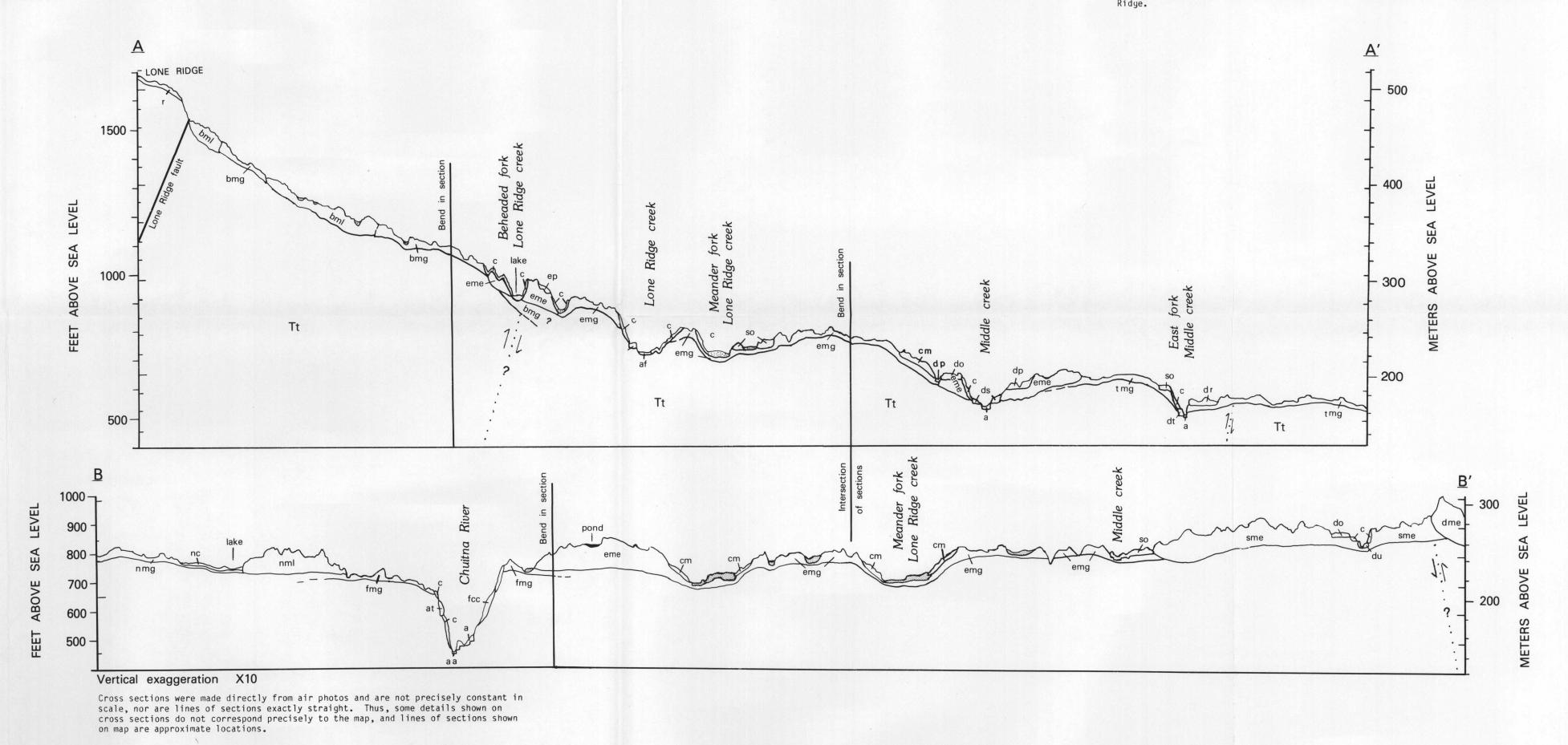


Figure 6.--Map of northwestern quarter of Tyonek A-4 quadrangle summarizing principal outwash trains related to Denslow Lake (D), Seven-thirty lake (S), Eight-ten lake (E), and Nikolai (N) moraines. Outwash trains identified by same lower-case letter symbol as used on surficial geology map, except that initial letter, d, is omitted from those for Denslow Lake moraine. Moraines outlined by bold lines, ticks on side toward glacier. Coarsely stippled pattern indicates areas of older moraines, including erratics on Lone



SURFICIAL GEOLOGIC MAP OF THE NORTHWESTERN QUARTER OF THE TYONEK A-4 QUADRANGLE, SOUTH-CENTRAL ALASKA

Henry R. Schmoll and Lynn A. Yehle

1987

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